INSTRUMENTATION FOR SEMICONDUCTOR FABRICATION WINS R&D 100 AWARD

Payoff

New instrumentation developed for in-line wafer-state diagnostics and process control for semiconductor fabrication could save the electronics industry up to $4 billion annually when fully implemented. The new technology will improve yield, decrease reactor down-time, reduce the need for test-wafers, shrink process excursions and tighten development cycles.

Accomplishment

The development of in-line wafer state diagnostic and process control instrumentation for the fabrication of epitaxial silicon and other thin films was recognized by R&D Magazine as one of the 100 most technologically significant products of 1996. This instrumentation, which uses a rugged, compact, ultra-stable and vibration-tolerant Fourier-transform infrared (FT-IR) sensor, can improve the accuracy of thickness-measurements by a factor of 10.

Background

The primary goal of the semiconductor industry is to increase device density and lower per circuit cost, while increasing yield and throughput. The most direct method to achieve this goal is through real-time process monitoring and control. Reducing the time required for obtaining high yields for new semiconductor products is particularly attractive, due to military requirements for high priority components in small quantities at low costs. Prior to this effort, only a few projects had been initiated dealing with in-line or in-situ sensing. These sensors, using ellipsometry, reflectometry, pyrometry and emission spectroscopy provided limited data and had not been widely used. More versatile sensors, and the control technology that used the sensor data, were needed to achieve the potential benefits of improved manufacturing. A new method to relate the infrared reflectance to the epitaxial doping profile was developed under a Materials and Manufacturing Directorate sponsored Small Business Innovation Research Phase I effort. It was during Phase II of this effort when Advanced Fuel Research Inc. and On-Line Technologies Inc. jointly developed the FT-IR sensor for in-situ, in-line and at-line diagnostics of film thickness, composition and temperature. With Applied Materials Inc., they introduced this in-line epitaxial silicon doping profile sensor for process monitoring by mounting it directly on the cool-down chamber of Applied Materials Centura single wafer cluster tool. Measurements of combined film thickness and composition are made using FT-IR reflection spectroscopy.